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The effect of VMI strategy in the supply chain of
South-to-North Water Transfer Project

Abstract: Vendor managed inventory (VMI), also known as consignment inventory on other occasion, has been widely used in various industries. The South-to-North Water Transfer Project (S2NWTP) is public infrastructure dispatching the surplus water from southern to northern district. In this paper the implementation of VMI of S2NWTP went through two main stages, i.e. conceptualization and definition, full implementation with Decision Support System (DSS) and the function evaluation. Firstly the VMI system of S2NWTP is described. Next the VMI strategy of S2NWTP is explained explicitly by using water-tank conception model. The special Decision Support System (DSS) is introduced to improve the effect of VMI and benefit of VMI to each part of S2NWTP is evaluated.

Keywords: VMI; S2NWTP
1. Introduction

1.1 South-to-North Water Transfer Project (S2NWTP)

South-to-North Water Transfer Project ((S2NWTP) is one of China’s largest trans-century projects aimed at transferring water from southern China to northern China to meet the increasing demand for water resources in northern China, where the shortage of water has been a serious constraint to the regional economic development. It has three route called eastern route, middle route and western route [1].

S2NWTP involves so many provinces and cities, each province is bounded rational and concerned with optimizing their own objectives, Huimin Wang firstly applied SCM which focuses on the coordination of different part of the supply chain to achieve “communication and coordination” of S2NWTP. It’s believed when S2NWTP treated and operate as a special water supply chain rather than just a water transfer project like before can increase the performance and efficient [2].

There are so many methods to reach the coordination of the supply chain, VMI is an important strategy to share information both demand and inventory. Vendor managed inventory (VMI), also known as consignment inventory on other occasion, has been widely used in various industries, different sectors have coined alternative terms covering essentially the same idea of VMI [3]. Quick response (QR)[4], efficient consumer response (ECR)[5], collaborative planning, forecasting and replenishment (CPFR)[6] and centralized inventory management(CIM)[7], in essence, they are all specific as applications of VMI [8]. Under a VMI system, the supplier decides on the appropriate inventory levels of each of the products and the appropriate inventory
policies to maintain these levels\textsuperscript{[9]}. In S2NWTP, we intent to demonstrate the strategy of VMI can be used same as other field of industries.

The structure of the paper is as follows: Firstly the VMI system of S2NWTP is described. Next the VMI strategy of S2NWTP is explained explicitly. The special Decision Support System (DSS) is introduced to improve the effect of VMI and benefit of VMI to each part of S2NWTP is evaluated.

2. VMI system of S2NWTP

Before S2NWTP there are some smaller water transfer projects, the price of water supply to industry and agriculture is mostly based on cost, and water suppliers are authorized by government, there are no profits for water suppliers. But S2NWTP is a different one to other projects, S2NWTP is planned to operate in the water market, and the government allows the suppliers to own profit, so water can be sold and traded as a special commodity under the regulation of government. This is the reason why supply chain management can be applied to S2NWTP.

In this paper we just take the eastern route of S2NWTP for example to illustrate the VMI structure of S2NWTP supply chain to achieve the coordination object.

According to the plan of S2NWTP the eastern route contains Jiangsu Province, Shandong Province, Hebei Province and Tianjin city, the surplus water of Yangtze River is pumped by a special route passing nature reservoir of Hongze Lake, Luoma Lake, Nansi Lake, Dongping Lake, which can be treated as Water District Distributor. Special commodity and Special route determines special VMI system (Refer to Fig.1). Fig.1 illustrates the vendor, which can be defined as the seller of water, Jiangsu
Province for example responses for the demand and inventory management of WDDs. The surplus of Yangtze River is pumped to those WDDs and they play roles of distributor in each district. Customers can be defined as by many means, it can be the lower level of water retailer or can be divided as the agriculture group, the industry group and the living group such as drinking water.

![Fig.1 VMI system of S2NWTP](image)

3. VMI strategy of S2NWTP

As an important strategy of coordination of supply chain, S2NWTP also need the VMI strategy to coordinate the different part, vendor and distributors (see fig.1). We
use water-tank model to illustrate our VMI strategy of S2NWTP, which is initially existed in Holmström’s paper\textsuperscript{[10]}. In order to identify the VMI strategy of S2NWTP, We compare the traditional strategy of other water transfer project to VMI strategy of S2NWTP.

Traditionally each distributor gives the order quality of water to supplier, and each supplier will pump water to each distributor. In other word, each level in the Supply chain places production orders and replenishes stock without considering the situation at either tiers of the supply chain. This is how most water transfer still operate, no formal collaboration and coordination between the retailer and supplier. In one hand, in order to avoid the situation of shortage of water, suppliers will store water to reservoirs, but when flood occurs, the pumped and stored water will be wasted, because the volume of reservoirs is limited. In other hand the supplier only has the information of distributors and not the customers’, Relying on purchase orders only often cause the bullwhip effect, as there is no visibility of the actual demand\textsuperscript{[11]}. Lastly, but not the least, operate in the traditional way the distributors will amply their order of water quality because of bounded rational and arbitrarily thought of water shortage which contribute to bullwhip effect.

In S2NWTP VMI strategy can be illustrate by the conception model of water-tank analyses (Refer to Fig.2). In Fig.2 it’s shown that the task of generating the replenishment order is given to the supplier, who then takes responsibility for maintaining the distributor’s inventory, and subsequently, the distributor’ service levels. Under VMI settings, the distributor has given the responsibility for placing
replenishment orders to the supplier. Having full visibility of the stock at the distributor’s site and the demand of customers, the supplier is wholly responsible for managing the inventory. That way, the inventory investment needed to maintain customer service levels can potentially be reduced. In effect the supplier has a dedicated process to generate exactly the same replenishment orders based on the same information that the distributor previously used to make its purchase decisions. The difference is that in shortage situations the supplier prioritizes customers for whom it is responsible for managing the inventory. What more, the scale effect can be achieved if the vendor manage the demand and inventory and replenishment plan by a single Decision Support System, which requires lots of investment and high consignment of different WDDs.

![Fig.2 VMI strategy of S2NWTP](image)

4. DSS of VMI of S2NWTP and the function of VMI to each part

In practical, to make the decision of replenishment and improve the effect of VMI of S2NWTP the following Decision Support System (DSS) is introduced. The DSS is based on the cycle of “Forecast, Decision, Implement and Updating”. In the matter of
fact, the DSS of S2NWTP in some extent is equal to the system of dispatch decision system, what quantity of flow, what quality of water, what time, to which place. Many researchers of china has done a lot to build the model of forecast, decision and dispatching \cite{12} \cite{13}. The detail technology issue we will omit here, we just give the conception and step of DSS of S2NWTP”. Information in Fig.3 means demand information, weather information, water available information and so on related to demand and water. CSL donates Customer Service Level, which related to the quality and the water sufficient and timely supplying. Based on those information the vendor use forecast model to forecast the water demand quantity of different WDDs, then the vendor make decision of dispatching plan using decision system and follow the plan to dispatch water to different WDDs. WDDs play the role of distributor in this supply chain and sell water to customers, in this process they handles the data of real data of sales. The real sale data of water, which equals to POS data of other grocery field, alone with historical sales data can be input to updating model and the results of parameter update can modify the forecast model and give a more reasonable one. The above description is a cycle of DSS, in order to form a more accurate vendor DSS the cycle implement several times.
Based on the effect of VMI application in the other field, specifically VMI of S2NWTP offers the following benefits. For the WDDs of distributor:

(1) VMI offers WDDs more effective inventory management of reservoir than before and less uncertainty and improves the Customer Service Level (CSL). The VMI system provides WDDs a way to set and achieve performance targets for both these goals.

(2) It’s a cost-effective way to obtain sales forecasting and inventory management services. As the vendor's implemented the system across many distributors rather than a single independent distributor, economies of scale were achieved which said before. This lead to a VMI forecasting system that was more accurate and developed at a lower cost than could be realized by any WDDs.

For the vendor:
(1) VMI provides a method for the vendor to increase their sales of their water commodity, because other sources of water are available, such as local precipitation, underground water. In some extent they are competitive both in quantity, quality and time. If the vendor supply water without the system of VMI, relying on actual sales data occurs when time lags, coupled with batch order from the retailer, it tends to amplify demand fluctuations, which decrease the supply chain profit.

(2) VMI also reduces the opportunity and incentives for gaming. For example, retailers sometimes intentionally inflate orders when production of supplier is limited and the information of supplier capacity of production is unavailable to the WDDs. But the vendor understand his own capacity well, the plan of order quantity and replenishment for WDDs which is decided by the vendor is more reasonable and feasible.

5. Conclusion

In this paper take the background of S2NWTP, the VMI system of S2NWTP is described, the characteristic of the system is a single vendor and multiple Water District Distributors (WDDs). The implementation of VMI of S2NWTP went through two main stages, i.e. conceptualization and definition, full implementation with Decision Support System (DSS) and the function evaluation. Firstly, conception of VMI of S2NWTP is illustrated by the water-tank model. Then, the DSS is introduced based on the original water dispatch system. Lastly, by comparing of VMI strategy to
traditional ones, the function of VMI strategy is found, VMI benefit both vendor and distributors.

The effect of VMI on the Bullwhip Effect in the S2NWTP using simulation method must be explored, which is our future research interest.

Reference:


